

Chapter 8.

Definition of immunity, Types of immunity, Importance of immunity against parasitic infections, Resistance of host to parasitic infection/infestation

Definition of immunity:

1. Immunity can be defined as the resistance offered by the host towards the injury caused by the microorganism and their products.
2. The capacity of all living being to protect itself against entry of a living or non-living foreign material is called immunity.
3. Immunity can be defined as an inherited, congenital or naturally or artificially acquired status in which various physical, biological and chemical factors result in an individual or group or a race, being resistant or relatively resistant to the occurrence and effects of a specified abnormal condition, with special reference to one that is caused by an infectious agent or its products.

The immune response to parasitic infections is in principle based on the same components as the response to other infectious agents. The relative importance of the single components, the interactions between them and the resulting effector mechanisms are highly variable, depending both on the species of parasite and the host. During the last few decades, much progress has been made in describing the immune mechanisms operating in helminth and protozoan infections of domestic livestock, especially domestic ruminants. However, there are still profound gaps in our knowledge even on the most important diseases and our basis for evaluating prospects for vaccination still does not exist for many infections.

Parasitic infections typically stimulate a number of immunological defense mechanisms both antibody and cell mediated and the responses that are most effective depend upon the particular parasites and the stage of infection.

There are always several immunological effector mechanisms involved in host defense against particular parasites, and the parasites have many different ways of evading

them. Some even exploit cells and molecules of the immune system to their own advantage. *Leishmania* species live in macrophages and use complement receptors to effect their entry, thus avoiding products of the oxidative burst.

Parasitic infections are usually chronic. Among the consequences of chronic infections are:- the circulating antigens, persistent antigenic stimulations and the formation of immune complexes. Hence levels of immunoglobulins are raised, IgM in trypanosomiasis and malaria, IgG in malaria and visceral Leishmaniasis and the IgE in worm infections. Splenomegaly occurs in most parasitic infections. Immunosuppression and immunopathological effect occur often.

In general, the cell mediated responses are more effective against intracellular protozoa, while antibody is more effective against cellular parasites in blood and tissue fluids. With single infection, different immune responses may act against different developmental stages of the parasite. Thus in malaria, while antibody against extracellular forms block their capacity to invade new cells, cell mediated immunity prevents the development of the liver stage within the hepatocytes.

Importance of Immunity against Parasitic Diseases:

With the advancement in the knowledge of immunology, it is becoming increasingly possible to diagnose the intricate imbalances resulting in the disease state and to evolve effective therapeutic and preventive approach in human as well as veterinary medicine. Parasitic infection induces a marked degree of immune responses in the host which nevertheless is highly variable. The immune responses may be protective as in Oriental sore, harmful as in the hypersensitivity phenomenon that occurs during the burst of hydatid cyst leading to anaphylactic shock, and helpful for survival and proliferation of parasites for example *Leishmania* inside the phagocytic cells.

Immune System:-

The system which deals with production of the immunity is called immune system. In vertebrate host the immune system comprises of macrophages, lymphocytes, thymus, bone marrow, bursa fabricius (in birds).

Mechanism of immunization:-

The invading organisms generally breaches the mucous membrane or skin and enters the body. The presence of foreign body triggers a reaction. The macrophages entrap the foreign body and with proteolytic enzymes the macrophages digest the organisms and break it into macromolecules. The structures of these molecules is then presented to the surface receptors on the lymphocytes. These structures are recognized by these receptors and the specific antibodies are produced and released into circulatory system. These structural details are also stored in memory so that on repeated exposure the memory can be activated and production of antibodies carried out immediately.

What is an antigen?

An antigen is a high molecular weight substance which when entered into the animal body, stimulates the production of antibody, and on mixing with the specific antibody reacts with it in some observable way.

Characters of antigen:-

Antigenic compounds of parasitic cells are lipoproteins mucoproteins, glucoproteins nucleoproteins and glycolipids. Antigens having higher molecular weight are more antigenic. Sometimes a non-antigenic small molecule can be made antigenic, if adsorbed on adjuvant. Certain lipids and poly saccharides from parasites are able to combine when injected alone. Such substances are known as haptens.

Types of antigen:-

i. ES antigen :-

The antigens from excretions (E) and secretions(S) of the parasite is called ES antigen.

ii. Somatic antigen:-

Antigens elaborated by the entire body of the parasite is called somatic antigen.

iii. **Internal antigens:**

These antigens are produced after the disruption of the parasite.

iv. **External antigens:**

These antigens are normally manifested by the intact parasite.

v. **Released antigens:-**

These antigens are the metabolic products of the parasites and are more or less same as external antigen.

vi. **Autoantigens:-**

These are self antigens which stimulates the formation of autoantibodies.

What is antibody?

Antibodies can be defined as a substance produced in the body fluids of an animal in response to a stimulus provided by the introduction of an antigen into the tissues and when mixed with that antigen, reacts with it in same observable way. Antibodies are the products of those cells of the body which synthesize globulins.

What is Immunoglobulins?

The members of serum proteins containing antibody activity are called immunoglobulins. These immunoglobulins are extremely heterogenic in respect to their electrophoretic mobility and molecular size. These are classified into 5 main classes: IgG, IgM, IgA, IgD and IgE.

Common terminologies used in immunology:

1. Antitoxin:

These are antibodies produced in response to the introduction of toxins. These can neutralize the homogenous toxins.

2. Cytolysins:

These are the antibodies which can bring about the lysis of the cells like erythrocytes, protozoa, bacteria, etc., when combined with complement.

3. Complement :

Complements are the substances of mixed globulin composition present in the normal serum. It does not combine with antigen alone. Its activity is lost when serum is heated at 56°C for 30 minutes.

4. Opsonins:

They are antibodies that render the antigens more sensitive for phagocytosis by leukocytes. The presence of complement is essential for opsonization.

5. Agglutinins:

They are antibodies which when mixed with the suspension of insoluble antigens cause flocculation or agglutination.

6. Agglutininogen:

They are antigens which induce the formation of agglutinating antibodies.

7. Precipitins:

They are the antibodies which cause precipitation of soluble antigens.

8. Precipitinogens:

They are antigens which induce formation of precipitating antibodies.

9. Hamagglutinins:

An antibody which reacts with surface antigen determinant or red cells to cause agglutination of red cells.

Principles of Immunity:

A) Natural immunity:-

Host can be considered naturally resistant of parasites because, through geographical distribution, behavioural characteristics or nutritional habits, they simply do not come into contact with infective stages. Natural resistance is a physiological incompatibility between parasite and host environment that prevents invasion, establishment or survival

without the intervention of immunologically based protective responses. Natural immunity may be divided into two types:- **Primary Defence** and **Secondary Defence** or **Innate Immunity** or **Non-specific Immunity**.

a) Primary defence:

i) Skin and mucous membrane act as natural barriers for the entry of organisms into the body. The chemical substances of sweat destroy the organisms. Saliva has the flushing and bactericidal action that protects the host from the entry of microorganisms. Continuous flows of tear flush the conjunctiva and make the eye free from particles and the lysozyme destroys most of the microorganisms. The sticky mucus, lysozyme and hairs of nose mostly remove 90 percent of inhaled particles and microorganisms. Some of the inhaled material is coughed out. Some of the ingested materials are destroyed by the action of the acidic gastric juices. The low acidic urine and its flushing action during urination removes most of the organisms.

ii) Body temperature is another physical barrier that combats with the infections.

b) Secondary defence:

It is an inherited non-immune defence mechanism of the host defence against an infectious agent to keep the animal free from infection. It may be absolute (*Leishmania tropica*) or partial (*Balntidium coli*). Following factors are responsible for innate mechanism:-

- i. Species of the host
- ii. Age
- iii. Racial difference
- iv. Genetic influences or Genetic immunity
- v. Diet
- vi. Hormonal influences
- vii. Intercurrent diseases
- viii. Geographic distribution
- ix. Habitat

B) Acquired Immunity or Acquired Resistance:-

The resistance may be acquired during the life time of an animal as a result of previous infection or inoculation called acquired immunity. It may be **active** or **passive**.

a) Active immunity:-

It is acquired by an individual or animal in response to the introduction of live infection or dead culture or culture filtrate into the body and the cells of the body take part in the formation of antibodies. The active immunity may be **natural** or **artificial**.

i. Natural active immunity:-

This is acquired after an infection and recovery from the disease or subclinical infection after repeated exposure to small doses of the infective organisms.

ii. Artificial active immunity:-

It may be acquired artificially by inoculation of the parasites or their stages or products in one of the following ways:-

- By inoculation of the living organisms
- Organisms killed by heat or phenol without altering the antigenic structure
- Products of organism.

Premunity, Sterile immunity and Autoimmunity are the examples of active immunity.

Premunition (Incomplete immunity):

Premunity is a low grade persistent infection which prevents further infection but is subjected to change as a result of changes in the circumstances of the host. Factors like stress and intercurrent diseases may enhance the virulence of the parasite and set up clinical infections. It is partial immunity because on loosing premune state, the animal is susceptible to reinfection. Premunition is a compromise situation between the parasite and the

host where both of them are able to live. The role of premonition is to check the number of parasites rather than to cause its complete elimination. It is effective against homologous antigen only but is ineffective against a strain other than the original one. It operates in Babesiosis and Trypanosomiasis and Theileriosis.

Sterile immunity:

This is an immunity maintained by the host after the parasite has been eliminated. The process begins like premonition. The immunity is clearly revealed by the destruction of all the parasites, and the lymphoid-macrophage system remains sensitized for years if not for whole life, e.g., *Theileria* infection in cattle

Autoimmunity

The production of antibodies by the body against one of its unmodified native components or against foreign antigens whose antibody cross reacts with a native self antigen. The phenomena is more common in blood protozoan parasites. A common reaction to it is the anaemia due to destruction of erythrocytes in which even the uninvaded cells are destroyed. *Leishmania*, *Trypanosoma*, *Babesia* and *Plasmodium* infection.

b) Passive immunity:

In this type of immunity, the readymade antibodies from the animals actively immunised are transferred to the individual. This immunity is short lived. It may also be passed to the foetus in the womb or to the newborn through first milk or colostrums of the mother or passive immunity is that form of immunity produced in an individual by antibodies derived from another individual either by natural transfer or by injection. It is only temporary, lasting for a few weeks to a few months, whereas active immunity is normally for more duration. It may be **natural** or **artificial**.

i. Natural passive immunity:-

When it is conveyed naturally from mother to offsprings by placenta or colostrums or milk it is called natural passive immunity.

ii. Artificial passive immunity:-

If an animal be made highly immune to a disease by repeated injections of any antigens, antistances are produced in its bloodstream in great excess. This is called hyperimmune. The small amount of this serum contains large quantity of antibodies. If such serum is injected into a healthy animal will produce immunity for short period. The animal used for such purpose is called **Serum taking animal** and the process is termed as **Hyperimmunisation**.

Effects of immune response:-

The effects of immune response may be grouped into three:-

- i. The development of immunity after a primary infection usually expels the worms
- ii. Host can limit reinfection by preventing the migration and establishment of larvae or sometimes, by arresting their development at larval stage.
- iii. Adults which do not develop are stunted in size and their fecundity is reduced

Self cure phenomena :-

It is seen that sheep carrying an established infection of *Haemonchus* expels the infection after a superimposed challenge infection with larval stage and thereafter were refractory to further challenges for some time. The phenomena of expulsion of adult worm is known as **Self cure phenomenon**.

References:

- Jain, P.C. 2002. General Veterinary Parasitology. First Edition. Jaypee Brothers. Medical Publishers (P) Ltd. New Delhi.
- Gaafar, S.M. Howard , W.E. and Marsh, R.E.(editors). 1985. World Animal Science. B. Disciplinary Approach. 2. Parasites, Pests and Predators. Elsevier Oxford.

Further reading:

- Roitt, I.1985. Essential Immunology. Fifth Edition. P.G.Asian Economy Edition New Delhi.

